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IS 12550 (1988): Methods of determining particle size distribution of iron ore fines [MTD 13: Ores and Raw Materials]



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Indian Standard

METHODS FOR DETERMINING PARTICLE SIZE DISTRIBUTION OF IRON ORE FINES

भारतीय मानक

लोह अयस्क के छोटे कणों का साइज वितरण ज्ञात करने की पद्धति

UDC 622.341.1 : 620.168.36

DESCRIPTORS : IRON ORE FINES, PARTICLE SIZE DISTRIBUTION.

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 3

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 25 August 1988, after the draft finalized by the Methods of Sampling Sectional Committee had been approved by the Structural and Metals Division Council.

The object of this standard is to provide uniform methods for determination of particle size distribution of iron ore fines.

In reporting the results of test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960.

Indian Standard

METHODS FOR DETERMINING PARTICLE SIZE DISTRIBUTION OF IRON ORE FINES

1 SCOPE

1.1 This standard deals with the methods for determining particle size distribution of iron ore fines in a lot. The methods for determining a particle size for lumpy ores and sized ores are detailed in IS 1405 : 1982.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard :

IS No.	Title
2 : 1960	Rules for rounding off numerical values (<i>revised</i>)
460	Test sieves
(Part 1) : 1985	Wire cloth test sieves (<i>third revision</i>)
(Part 2) : 1985	Perforated plate test sieves (<i>third revision</i>)
(Part 3) : 1985	Methods of examination of apertures of test sieves (<i>third revision</i>)
1405 : 1982	Methods of sampling iron ores (<i>second revision</i>).

3 GENERAL PRINCIPLES OF SIEVING

3.1 This method explains determination of particle size distribution of the lot by sieving, utilizing several sieves according to IS 460 (Part 1) : 1985 and IS 460 (Part 2) : 1985.

3.2 The various size fractions obtained by sieving are expressed in terms of percentage mass passing through or retained on the specified sieves.

3.3 The sieving shall be carried out on as received basis or on dry basis, either manually or by using mechanical sieve shaker.

3.4 The size distribution test shall preferably be carried out on each sub-lot size sample. The weighted mean of test results of all sub-lot size samples shall be reported as the size distribution of the entire lot.

3.5 When the sample is sticky or wet depending on the pretreatment it is likely that sieving efficiency will be lowered. It is desirable to dry the size sample thoroughly (at $105 \pm 5^\circ\text{C}$) before sieving.

3.6 For carrying out size distribution of fines containing approximately 40 percent or less by mass of size fraction under 150 microns, dry

sieving method shall be applicable. However, for those fines consisting mostly of size fraction 150 microns (more than 40 percent) and also for those fines where it is difficult to sieve under dry conditions, wet sieving may be applied.

4 ACCESSORIES FOR SIEVING

4.1 Rotap sieve shaker, fitted with a time switch having specifications :

Number of revolutions :	270-300/min
Number of tappings :	140-160/min
Stroke of shaking :	20-25 mm

Size distribution may also be determined on suitable sieve shakers of similar size.

4.2 The sieve shaker should accommodate at least 4 sieves of 200 mm diameter and a receptacle. It shall be fitted with a pug to receive the impact of tapping device.

4.3 Wire cloth test sieves and perforated plate test sieves shall be according to IS 460 (Part 1) : 1985 and IS 460 (Part 2) : 1985 respectively.

4.4 Balance

A balance having an adequate capacity relative to the mass of the sample shall be employed, having a sensitivity of at least 0.1 percent of the mass of the sample charged.

4.5 Brush

For cleaning the sieves, a soft brass brush shall be used for sieves coarser than 150 microns and a nylon brush for sieves finer than 150 microns.

4.6 Drying Oven

Capable of accommodating at least 5 standard test sieves and capable of maintaining a temperature of $105 \pm 5^\circ\text{C}$.

5 TEST SAMPLE

5.1 The entire size sample corresponding to each sub-lot, prepared as per IS 1405 : 1982 shall be used, for the test.

6 DRY SIEVING (FOR DETERMINATION OF PARTICLE SIZE UP TO 150 MICRONS)

6.1 General

6.1.1 The quantity of a fresh charge to be placed on a sieve, on as received basis or dry basis, at one time is selected by aperture size of the sieve, sieving area and the maximum particle size of the test sample as shown in Table 1. For other

sieve sizes, maximum charge would be worked out based on practical experience and sieving efficiency.

Table 1 Aperture Size of Sieves, Top Particle Size and Maximum Mass of Fresh Charge
(Clauses 6.1.1, 6.1.2, 6.2.1 and 6.3.2)

Sieve Aperture Size	Top Particle Size (mm)	Maximum Mass of Fresh Charge (Approximately 200 mm Dia Round Frame) (g)
10 mm	50	600
4.75 mm	30	600
1.70 mm	20	500
850 μ m	10	300
500 μ m	6	200
150 μ m	3	150
75 μ m	2	100
45 μ m	1.2	70

6.1.2 The test sample to be sieved shall be divided into several charges. Each charge is placed on the sieves one by one. The mass of each charge will depend on sieve aperture and area of sieving surface as indicated in Table 1.

NOTE — Table 1 is only a guideline. In practice, deviations are allowed.

6.1.3 Sieving Time

The end point of dry sieving shall be that stage of sieving when the mass of material passing the specification sieve in one minute is not more than 0.1 percent of the mass of the charge. If an end point is not reached within 30 minutes, an arbitrary sieving time shall be agreed to.

6.1.4 Intermediate sieves may normally be employed for successive sieving. Use of number of intermediate sieves may be restricted if the coarser concentrate particles are friable and prone to appreciable degradation during sieving.

6.1.5 If the quantity of sample to be sieved is appreciably large, sieving up to 4.75 mm size shall be carried out on the entire quantity of the size sample. Size fraction passing through 4.75 mm shall then be reduced, dried and sieving shall be continued with the finer sieves either manually or using rotap sieve shaker, using 200 mm diameter standard test sieves.

6.1.6 Collect the undersize fraction, during hand sieving, into a sufficiently large receptacle which will avoid scattering of particles.

6.1.7 The standard test sieves will, after a period of time, become less accurate. The sieves shall, therefore, be periodically checked according to IS 460 (Part 3) : 1985 and the correction factor to be applied to the results shall be determined.

6.2 Procedure of Manual Sieving

6.2.1 Hand sieving shall be, as a rule, started with the sieve having largest size aperture and then sieved with the sieves in the descending order of the sizes of aperture. Place the fresh charge of mass not more than the mass shown in Table 1 on the sieve having largest aperture size of the sieves to be employed for test sieving. Take the sieve with both the hands and move it to and fro horizontally about 60 times per minute at an amplitude of about 70 mm, with gentle tapping in between. When the end point is reached, collect the oversize and determine its mass. The undersize shall then be collected and sieved using the sieve with the next lower size aperture.

6.3 Sieving Using Rotap Sieve Shaker

6.3.1 The rotap sieve shaker shall be employed for screening particle size below 4.75 mm only. The undersize 4.75 mm fraction obtained by hand sieving in 6.1.5 after reduction and drying shall be the charge for sieving with Rotap sieve shaker.

6.3.2 The nest of sieves selected shall be assembled in consecutive order as to the size openings with the coarsest sieve at the top, the assembly being completed by a collecting pan below the bottom sieve. The charge, not more than that specified in Table 1, shall be placed on the top sieve and this sieve closed with a cover.

6.3.3 The sieve assembly shall then be held securely in the rotap sieve shaker and the shaker operated for a suitable period taking into account the end point rule.

6.3.4 The several fractions shall be removed from the nest of sieves by removing the coarsest sieve from the nest gently tapping its contents to one side and pouring them into a tared metal tray. Any material adhering to the bottom of the sieve and frame shall be brushed with soft brush into the next fine sieve. This sieve just removed shall be tapped, upside down into the same tray. This fraction shall be weighed. This process shall be repeated for each sieve in the nest and the fraction collected in the pan shall be removed and weighed. The process shall be repeated with the next charge till the whole sample is sieved. Care shall be taken to see that the sum of masses of all the fractions shall not be less than 98 percent of the mass of the test sample. The masses of the fractions retained on each sieve and the mass of the fractions collected in the pan shall be expressed as percentages of the mass of the test sample and reported to the nearest 0.01 percent.

NOTES

1 The various stages of screening, drying, reducing of the test samples are shown in Annex A.

2 Any fraction less than 0.1 percent of the mass of test sample shall be reported as 'trace'.

**AMENDMENT NO. 2 AUGUST 2000
TO
IS 12550 : 1988 METHODS FOR DETERMINING
PARTICLE SIZE DISTRIBUTION OF IRON ORE FINES**
(Page 2, clause 6.3.2, line 4) — Substitute 'pan' for 'pen'.

(MTD 13)

Reprography Unit, BIS, New Delhi, India

6.3.5 Size distribution of the entire lot shall be calculated from the size distribution of each of the sub-lots as follows : If M_1 denotes the mass of the first sub-lot, M_2 the mass of the second sub-lot, etc, and if W_{1A} is the size fraction corresponding to first sub-lot, W_{2A} the size fraction corresponding to the second sub-lot, etc; then the average size fraction A for the lot is estimated as:

$$\frac{(M_1 W_{1A} + M_2 W_{2A} + \dots)}{M_1 + M_2 + \dots}$$

6.4 Wet Sieving Method (Method by Manual Sieving)

6.4.1 Wet sieving shall be carried out according to the guidelines given in 3.6.

6.4.2 Accessories for Wet Sieving

The following accessories shall be employed as indicated in Fig. 1.

- A pressure controlled supply of water fitted with a control valve and a pressure gauge;
- Spray nozzle attached to the pressure controlled water system;
- Collecting vessel of sufficient dimensions to receive the undersize portion of the sieved concentrate and of material which does not corrode with water; and

d) Standard sieves of 200 mm diameter with stainless steel wire cloth. Sieve of following aperture size may be employed: 1 mm, 500 μm , 150 μm , 75 μm , 45 μm .

6.4.3 The total charge and oversize fractions shall be dried after wet sieving. The undersize fraction passing through the smallest sieve shall be obtained by difference. Each particle size fraction expressed as mass percent shall be designated as on 'dry basis'.

6.4.4 Care shall be taken during wet sieving that water does not overflow the side of the sieve and scattering of sample due to the pressure of spraying water shall be avoided.

6.4.5 End point of sieving is reached when the water passing through the sample on the sieve is clear.

6.4.6 Wet sieving may be carried out by mechanical sieving as using a Rotap sieve shaker fitted with a wet sieving attachment.

6.4.7 Preparation of Sample

The size sample prepared from each sub-lot according to IS 1405 : 1982 shall be reduced to about 3 kg by means of increment reduction method. This reduced test sample shall be weighed and dried to $105 \pm 5^\circ\text{C}$ before conducting wet sieving.

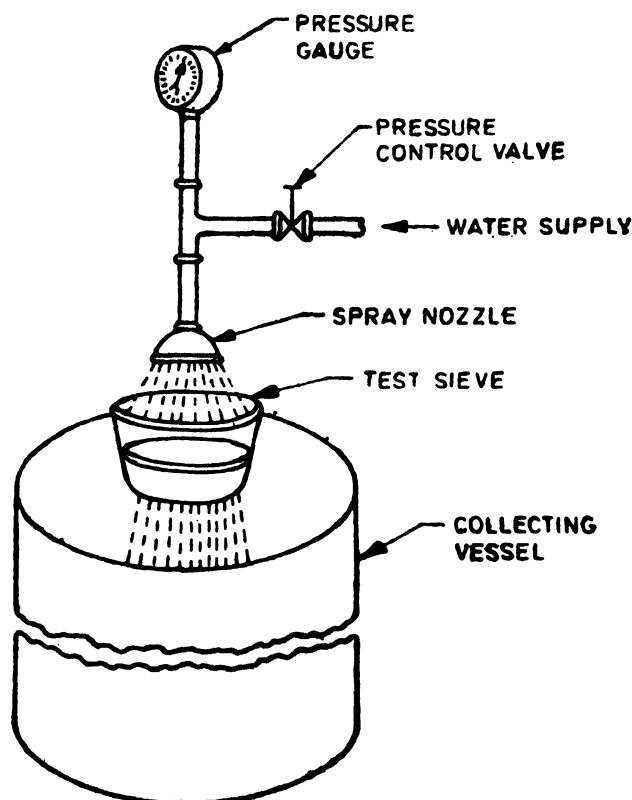


FIG. 1 ASSEMBLY FOR MANUAL WET SIEVING

6.4.8 Procedure

Dry the entire test sample prepared under 6.4.7 and record its mass (W_B). This sample shall be wet sieved in small charges. Place the mass of the charge not more than 300 g on the sieve. Carry out wet sieving on this charge, using the wet sieving accessory arrangement as shown in Fig. 1 till the end point is reached. Recover the oversize fraction in a vessel by means of jets of water. Repeat this process with next charge recovering the oversize and combining all the oversize fractions till the entire test sample is sieved. The undersize fraction so collected shall be the charge for the next sieve. The procedure is repeated using sieves with different apertures. Upon completion of test sieving each of the oversize fractions shall be dried separately weighed to the nearest 0.1 g and reported as $W_1, W_2, \dots, W_k$ and the sum of these masses W_T shall be calculated. The mass of the dried size fraction passing through the smallest aperture size W_L is calculated by difference, using the following formula:

$$W_L = W_B - W_T$$

$$W_T = \sum_{i=1}^k W_i$$

6.4.9 Calculation

6.4.9.1 Each size fraction content in terms of mass percentage shall be calculated by the following formulae to the second place of decimal:

Each oversize content (percent)

$$= \frac{W_i}{W_B} \times 100$$

Undersize content of the smallest aperture sieve (percent) = $\frac{W_L}{W_B}$

where

W_i = mass of dried oversize sample retained on sieve of aperture i mm in g,

W_B = mass of the entire test sample (dried) in g, and

W_L = mass of the dried size fraction passing through the smallest aperture.

NOTE — An example of method of determination of size distribution of the sub-lot of fines by wet sieving is given in Annex B. The size distribution of the entire lot is calculated by taking weighted average the weights being sub-lot mass.

ANNEX A (Clause 6.4.9.1)

AN EXAMPLE OF THE METHOD OF DETERMINATION OF SIZE DISTRIBUTION OF A SUB-LOT SAMPLE OF FINES, BY SIEVING AND CALCULATION OF SIZE DISTRIBUTION ON AS-RECEIVED BASIS

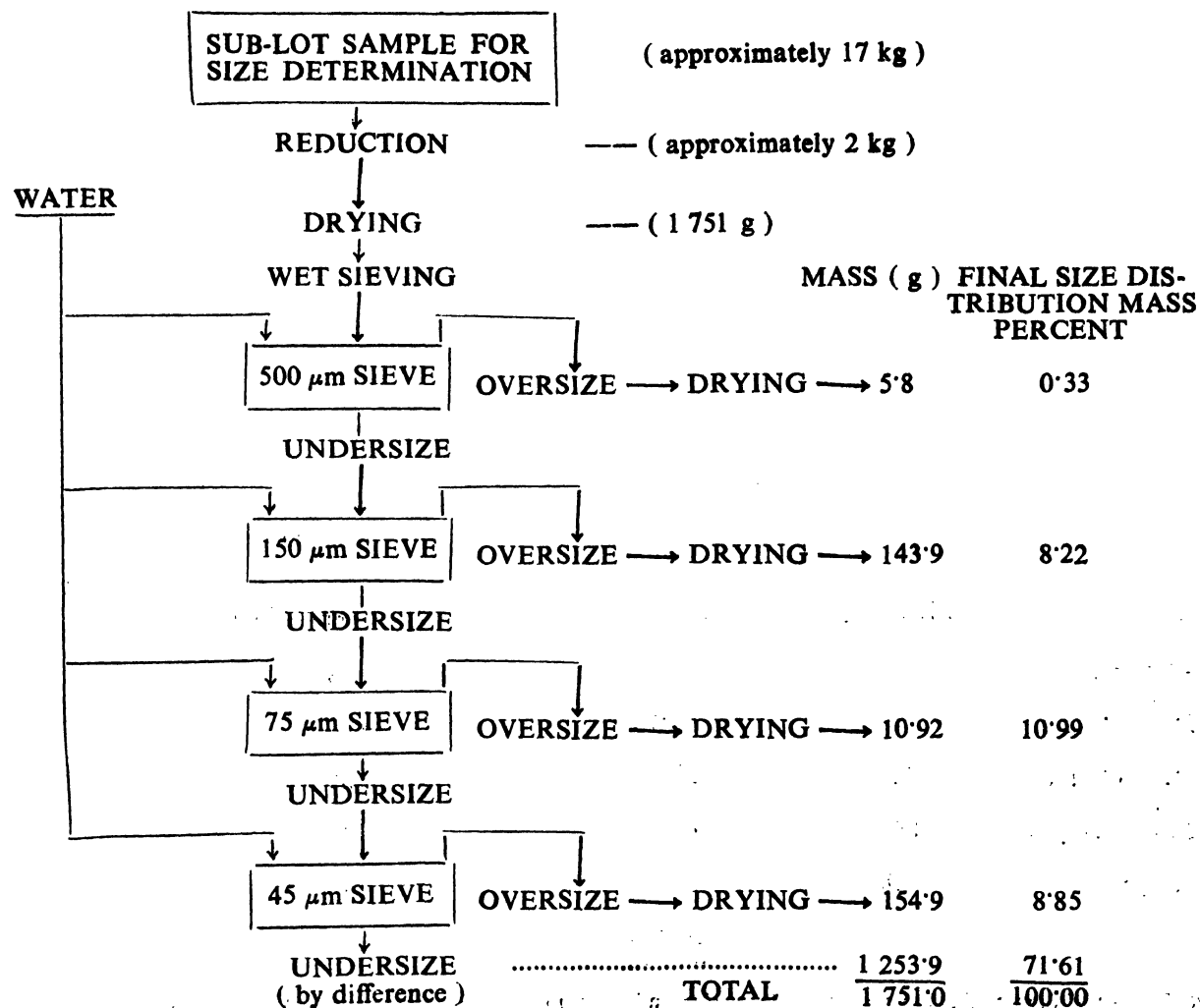
SUB-LOT SAMPLE FOR SIZE DISTRIBUTION		(approximately 17 kg)		
SIEVING		Mass (kg)	Mass (percent)	Final Mass (percent) (On as-received basis)
↓				
+10 mn		NIL	—	—
↓				
-10/+4.75 mm		1.140	6.83	6.83
↓				
-4.75 mm		15.600	93.17	
↓				
MIXING AND DIVISION				
↓				
SAMPLE (1.79 kg)				MASS PERCENT CALCULATED ON AS-RECEIVED BASIS (Split into further size fraction)
↓				
DRYING				
↓				
SIEVING		MASS (g)	MASS (%)	MASS percent × 93.17
↓				100
+2.6 mm		140	7.82	7.28
↓				
-2.6/+1.7 mm		300	16.76	15.62
↓				
-1.7/+0.5 mm		370	20.67	19.26
↓				
-500/+150 μm		830	46.37	43.21
↓				
-150 μm		150	8.38	7.80
		100.00		
			TOTAL	100.00

NOTE — '+' Sign prefixed to a sieve aperture size indicates material retained on that sieve after sieving; '—' sign indicates material passing through that sieve after sieving.

ANNEX B

(Clause 6.4.9.1)

AN EXAMPLE OF THE METHOD OF DETERMINATION OF SIZE DISTRIBUTION OF A SUB-LOT OF IRON ORE FINES USED AS PELLET FEED BY WET SIEVING



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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices:

Telephone

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002

{ 331 01 31
{ 331 13 75

Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola
CALCUTTA 700054

36 24 99

Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036

{ 2 18 43
{ 3 16 41

Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113

{ 41 24 42
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Western : Manakalaya, E9 MIDC, Marol, Andheri (East)
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